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Cover Page Footnote

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LITERATURE REVIEW: PROGRESSIVE TIME DELAY AS AN INSTRUCTIONAL METHOD FOR STUDENTS WITH AUTISM SPECTRUM DISORDER

By Mindy Medrana & Natalia Allen

I. INTRODUCTION

Many individuals diagnosed with Autism Spectrum Disorder (ASD) experience decreased levels of independent functioning compared to those without a disability diagnosis (Brown, et al., 2011). Statistics gathered from the World Health Organization (2011) indicate that adults with ASD have limited employment opportunities with which they can support themselves, and the health risks associated with ASD affect their eligibility or earning wage on the jobs they may be offered. Compared to students who are typically developing, children and adolescents with ASD have a greater risk of being diagnosed with psychiatric disorders, such as high anxiety and obsessive-compulsive disorder, which affect academic success and social interactions (Brereton et al., 2006). ASD is a neurodevelopmental disorder that primarily impacts verbal and nonverbal expression (Amaral et al., 2008). According to the National Autism Indicators Report (2017), students with ASD tend to exhibit poorer post-school outcomes than students who are neurotypical. Efforts made to minimize the discrepancy include federal laws mandating special education teachers to use evidence-based practices (EBP) when teaching students with disabilities (ESSA, 2015).

EBPs integrate the expertise of the instructor or interventionist and the perspective of the student and result in favorable student outcomes (Council for Exceptional Children, 2014). Time delay is an EBP that has been used to teach students with disabilities for several decades (Horn et

al., 2020). By definition, time delay is a near-errorless instructional procedure that involves the transfer of stimulus control from the prompt to task-related stimuli (Horn et al., 2020). There are two distinct forms of time delay used in the field of special education: constant time delay (CTD) and progressive time delay (PTD; Walker, 2008). Given the fact that both time delay procedures are near-errorless, the goal initially is to ensure students provide a correct response, albeit prompted. That is, the teacher or interventionist provides a controlling prompt immediately (i.e., 0 second delay interval) following presentation of the discriminative stimulus (Horn et al., 2020; Snell & Gast, 1981). Once the student provides correct responses reliably (e.g., three consecutive sessions), the controlling prompt is withheld for a predetermined delay interval (Ledford & Wehby, 2015). There are observable differences between CTD and PTD during the second phase. For CTD, each successive session will maintain a steady, predetermined delay interval (e.g., 4 seconds). In contrast, when using PTD, the delay interval will gradually increase in response to student behavior (Ledford & Wehby, 2015). For example, as the student provides independent correct responses, the delay interval in which the controlling prompt is withheld gradually increases. The controlling prompt is a stimulus that is most likely to incite the target behavior as a response (Horn et al., 2020). Below is a practical example of PTD and appropriate controlling prompt being used in a classroom when teaching a new skill to a student with ASD.

> *Ms. Bingley teaches Alex to sort office supplies using the PTD procedure at a 0- to 4-s time delay. She initially tells him to sort the supplies then immediately (at a 0-s delay interval) provides the controlling prompt (e.g., gesturing towards the correct bin) for the first item. Once Alex achieves the target skill 3 consecutive times at 0 s, Ms. Bingley instructs Alex to sort the supplies and waits for his response at a 2-s delay interval. After Alex completes 2 more consecutive trials of unprompted correct responses with a 2-s*

delay exhibiting 100% accuracy, Ms. Bingley increases the delay interval to 4 s. The delay interval gradually increases only after Alex achieves the target skill consecutively with 100% accuracy. If he places an item in the incorrect bin or does not respond, Ms. Bingley immediately interrupts and provides the controlling prompt. Alex reaches mastery criterion once he completes 3 consecutive trials independently at the longest delay interval with 100% accuracy.

Both CTD and PTD have been utilized as interventions when teaching students with ASD (Walker, 2008). Additionally, both time delay procedures have been shown empirically to result in favorable learning outcomes when teaching students with disabilities (Heckaman et al., 1998; Morse & Schuster, 2001; Norman et al., 2001; Taylor & Harris, 1995). However, there is a paucity of recent literature measuring the effects of PTD on skill acquisition in students with ASD. For that reason, we sought to examine investigations whereby the effects of PTD were measured over the last 30 years in an effort to guide research and current practice. The purpose of the present review of the literature was threefold. The first purpose was to examine the effectiveness of PTD when teaching students with ASD. The second purpose was to analyze methodological details across studies (e.g., learning environment, ages of participants) and determine whether these details influenced the efficiency of the PTD procedure. The third purpose was to examine the success in generalization and maintenance of the target behaviors by students with ASD who learned through PTD.

II. METHOD

A review of the literature was conducted to examine published research measuring the effects of PTD on teaching students with ASD over a 30-year period (1990-2020). Initial search procedures

included internet searches of the Education Research Complete database under EBSCOhost and an internet search of Google Scholar. The descriptor words used for the internet search included "progressive time delay", "autism", "adolescent", "ASD", "developmental disabil*", "IDD", "autism spectrum disorder", and "time delay." Secondary search procedures involved scanning the reference lists of electronically retrieved peer reviewed articles. Following the aforementioned search procedures, we retrieved electronic copies of all fitting articles for further analysis.

The initial search procured a little over 900 articles. First, the titles of the articles were reviewed and narrowed down to the ones that fit the desired criteria the best. This reduced the number of articles to 18. Next, the abstracts were analyzed to ensure the selected articles described an empirical investigation where the effects of PTD were measured when teaching students with a diagnosis of ASD. Consequently, the number of articles were reduced to 16. Finally, we conducted a full text analysis of the selected articles. Both authors followed search procedures independently to ensure reliability of retrieved publications. Articles were deemed appropriate if they met the following inclusion criteria: (a) study participants had a diagnosis of ASD, (b) participants that were between the ages of 4 and 22 years old, (c) the article was published between 1990-2020, (d) progressive time delay was used. Initially, the publication time frame was between the years 2000 and 2020. However, after some consideration due to the paucity of literature published during that time frame, we expanded the publication window to include a 30-year time frame.

Exclusionary criteria included: (a) studies that measured the effects of PTD but with a different disability diagnoses and no comorbidity, such as intellectual disability only; (b) participants who were three years old or younger, or those over the age of 22; (c) articles

published before 1990; and (d) studies that measured the effects of a time delay procedure other than PTD (e.g., CTD). In all, 11 peer-reviewed studies met inclusionary criteria for our review of the literature.

Table 1

Content Across Studies

Article	Participants	Diagnosis	Educational Placement	Intervention Setting	Target Skill and Learning Domain	Design	Generalization and Maintenance Measures	Acquisition of Skill
Smith et al., 2016	4 male students, ages 15 -19	ASD; 3 also with SLI	Self-contained classroom	High school outdoor courtyard, kitchen, and office	Self-instruction; vocational (e.g. prepare a letter)	MP x settings and subjects	+G (setting +2, interventionist +3) +M (1wk; +4)	+4
Matson et al., 1990	2 male students; 1 female student, ages 9 - 11	Moderate ASD	Self-contained classroom	School classroom	Spontaneous verbalization; communication (e.g. please, thank you)	MB x behaviors	+G (interventionist; +3) -M	+3
Charlop & Trasowech, 1991	3 male students, ages 7-8	ASD	Not provided	Home (i.e. kitchen, bedroom, living room), school (i.e. clinic, bus)	Spontaneous verbalization; communication (e.g. goodnight)	MB x subjects	+G (settings and interventionists; +3) +M (1yr; +3)	+3
Ingenmey & Houten, 1991	1 male student, age 10	ASD	Not provided	Home	Spontaneous verbalization; communication	MB x behaviors	+G (untrained responses and settings; +1) +M (4mo; +1)	+1
Matson et	3 male	Severe	Not	University	Self-initiated	MB x	+G (settings	+3 PTD

al., 1993	students, ages 4-5	ASD	provided	clinic	verbalizations; communication	behaviors	+3) +M (10mo; +3)	more efficient than fading procedure
Taylor & Harris, 1995	2 male students, 1F 5-9	ASD; 1 with echolalia	Private day school for children with ASD	School (i.e. classroom, hallway, bathroom)	Spontaneous questions; communication	MB x subjects	+G (setting and interventionist; +3) +M (post-test sessions; +3)	+3
Heckaman et al., 1998	4 male students, ages 6-9	Moderate to severe ASD (not specified per participant)	Self-contained classrooms	School	Disruptive behavior; social	Alternating treatments	-G -M	+4 PTD; +2 LTM
Ledford & Wehby, 2015	5 male students* ages 5-6	ASD	Self-contained and inclusive classrooms	School classroom	Verbal and nonverbal initiations/responses; academic & social	MB x subject groups and MB x behaviors	+G (setting +3) -M	+5
Winstead et al., 2019	3 male students* ages 7-8	Severe ASD	Self-contained MSD classroom	School classroom	Verbal responses; academic & social	MB x subject groups	+G (item +3) -M	+3
Carlile et al., 2013	4 male students, ages 8-12	ASD	Self-contained classroom	School classroom	Appropriate verbal/manual response; social	MB x participants	+G (setting and activity; +4) +M (schedule thinning; +4)	+4

Sweeney et al., 2018	1 male and 1 female student*, ages 4-5	ASD	Inclusive classroom	Preschool classroom	Peer imitation; social	MB x participants	-G +M (reinforcement thinning; +1)	+2

Note. MB = Multiple Baseline; G = Generalization; M = Maintenance; * denotes studies in which participants included those with and without ASD—only data from students with ASD were analyzed in the review of the literature

III. RESULTS

Table 1 displays essential information obtained from the 11 peer-reviewed articles that met inclusion criteria. Across these 11 studies, 35 participants had a diagnosis of ASD. The other participants observed were students who were neurotypical classmates of the students with ASD (Ledford & Wehby, 2015; Sweeney et al., 2018; Winstead et al., 2019). These studies included students without ASD (Ledford & Wehby, 2015; Sweeney et al., 2018; Winstead et al., 2019) to serve as peer groups with which the students with ASD could interact for intervention research purposes. However, given the aims and scope of this review, we analyzed data from participants with ASD only. As such, one study integrated peer group intervention (Sweeney et al., 2018). Two other studies paired students with ASD with students who were at-risk for academic performance issues (Ledford & Wehby, 2015; Winstead et al., 2019). Each student with ASD was determined by a variety of tests such as the Childhood Autism Rating Scale (Schopler et al., 1988). Of the 35 participants diagnosed with ASD, an overwhelming majority were male (n = 32). Following the guidelines from the World Health Organization, children are defined as individuals aged younger than 10 and adolescents are defined as individuals aged 10-19 years old. Based on this, more participants were classified as children (n = 27; Carlile et al., 2013; Charlop & Trasowech, 1991; Heckaman et al., 1998; Ledford & Wehby, 2015; Matson et al., 1990; Matson et al., 1993; Sweeney et al., 2018; Taylor & Harris, 1995; Winstead et al., 2019) than adolescents (n = 8; Carlile et al., 2013; Ingenmey & Houten, 1991; Matson et al., 1990; Smith et al., 2016) at the time the studies were conducted.

One notable characteristic of participants across studies was the concurrent condition of echolalia (n = 7; Charlop & Trasowech, 1991; Matson et al., 1990; Matson et al., 1993; Taylor & Harris, 1995). However, it must be noted that not every study elaborated on their participants'

conditions beyond the fact that they received diagnoses of ASD. A second notable characteristic of participants was their educational setting placement. Similar to the details of concurrent diagnoses, not all studies explicitly reported the educational setting placement of each of their participants. A great number of students received education in self-contained classrooms (*n* = 23; Carlile et al., 2013; Heckaman et al., 1998; Ledford & Wehby, 2015; Matson et al., 1990; Smith et al., 2016; Winstead et al., 2019) while a smaller number received education in inclusive classrooms (*n* = 7; Ledford & Wehby, 2015; Sweeney et al., 2018), leaving 5 participants whose educational setting was not explicitly listed in the study (Charlop & Trasowech, 1991; Ingenmey & Houten, 1991; Matson et al., 1993; Taylor & Harris, 1995).

The variance in severity of ASD and concurrent conditions in participants across studies corresponded to a variance in the target behaviors each study aimed for their participants to acquire. Researchers focused on target skills such as spontaneous verbalization, self-instruction, verbal and nonverbal initiation, verbal responses, peer imitations, and disruptive behavior. With each target skill, the controlling prompts and error correction procedures varied slightly between verbal instruction, verbal modeling, and manual prompts or modeling. These behaviors correlated with communicative, social, academic, and vocational skill categories to benefit the students in their future interactions. Spontaneous verbalization such as “please” and “thank you,” correlates with the communication skill category. Almost half of the studies focused on communicative skills (n = 5; Charlop & Trasowech, 1991; Ingenmey & Houten, 1991; Matson et al., 1990; Matson et al., 1993; Taylor & Harris, 1995) while the same amount of studies focused on social skills (n = 5; Carlile et al., 2013; Heckaman et al., 1998; Ledford & Wehby, 2015; Sweeney et al., 2018; Winstead et al., 2019), two studies doubled on academic skills (Ledford & Wehby, 2015; Winstead et al., 2019), and one focused on vocational skills (Smith et al., 2016).

Two studies specified both academic and social goals as their target skills (Ledford & Wehby, 2015; Winstead et al., 2019). Since different categories best suited particular settings, researchers conducted trials in certain environments. Correspondingly, research was categorized based on the setting in which the intervention took place, namely academic and home-based learning environments. The majority of studies featured academic settings (n = 9), which included a general or special education classroom (Carlile et al., 2013; Heckaman et al., 1998; Ledford & Wehby, 2015; Matson et al., 1990; Sweeney et al., 2018; Winstead et al., 2019), clinic (Matson et al., 1993), hallway (Taylor & Harris, 1995), and office (Smith et al., 2016). The remainder of the studies (n = 2) were conducted in home-based learning environments which included a bedroom (Charlop & Tresowech, 1991) and living room (Ingenmey & Houten, 1991).

Although all studies used PTD procedures as per our inclusion criteria, variations across procedural tasks include the time delay ranges, delay change increments, and experimental design. As per general PTD procedures, the initial trial always starts at 0s. The studies found preset their maximum time delay to either 4s, 5s, 6s, or 10s. Depending on the maximum time delay, they followed increments of 1s, 2s, or 3s. Some studies (n = 2; Heckaman et al., 1998; Matson et al., 1993) compared the efficiencies of PTD with an additional prompting procedure such as Least to Most (LTM) and visual stimulus fading. Regardless of any variation among the studies, all 35 student participants who received PTD intervention successfully acquired their target skill.

Of the reviewed research, nine studies included generalization measures (Carlile et al., 2013; Charlop & Trasowech, 1991; Ingenmey & Houten, 1991; Ledford & Wehby, 2015; Matson et al., 1990; Matson et al., 1993; Smith et al., 2016; Taylor & Harris, 1995; Winstead et al., 2019). That is, across 30 participants in the aforementioned investigations, researchers

measured how students with ASD transferred and applied acquired skills in a novel setting and/or when working with an unfamiliar adult. Similarly, seven studies included follow-up data (Carlile et al., 2013; Charlop & Trasowech, 1991; Ingenmey & Houten, 1991; Matson et al., 1993; Smith et al., 2016; Sweeney et al., 2018; Taylor & Harris, 1995), measuring participants' abilities to sustain acquired behaviors independently. Matson et al. (1990) did not collect generalization data systematically, but observed generalization data reported by parents and teachers. Generalization measures included conducting trials across settings (Charlop & Trasowech, 1991; Ingenmey & Houten, 1991; Matson et al., 1993) and interventionists (Smith et al., 2016; Taylor & Harris, 1995). Maintenance measures occurred across ranges of time from 1 week to 1 year (Ingenmey & Houten, 1991; Matson et al., 1993; Smith et al., 2016) and reinforcement thinning (Sweeney et al., 2018). Out of 30 participant generalization data reports, 27 students with ASD successfully generalized their target behavior according to generalization procedures established by the researchers (Carlile et al., 2013; Charlop & Trasowech, 1991; Ingenmey & Houten, 1991; Ledford & Wehby, 2015; Matson et al., 1990; Matson et al., 1993; Smith et al., 2016; Taylor & Harris, 1995; Winstead et al., 2019). Of the 19 participants from whom follow-up data was collected, all successfully maintained newly learned skills (Carlile et al., 2013; Charlop & Trasowech, 1991; Ingenmey & Houten, 1991; Matson et al., 1993; Smith et al., 2016; Sweeney et al., 2018; Taylor & Harris, 1995).

IV. DISCUSSION

The purpose of this literature review was to investigate the efficacy of PTD while teaching students between the ages of 4 and 22, all of whom had a diagnosis of ASD. We analyzed the efficacy of PTD on skill acquisition across studies published between 1990-2020. Findings

showed PTD interventions resulted in positive learner outcomes across each study reviewed. In all, 32 of the 35 participants were male and over two-thirds were classified as children (i.e., participants between the ages of 4 and 19). Nonetheless, PTD led to acquisition of a new target skill across all study participants (n = 35). Findings from our review of the literature showed PTD to be an appropriate intervention to implement with students with varying abilities across the autism spectrum. That is, PTD was not observed to be more effective for specific sub-groups of participants with ASD.

In our analysis of intervention settings, we found PTD to be an effective practice across learning environments, including school-based settings (e.g., classrooms, bathroom, courtyard), vocational settings (e.g., office), and home-based settings (e.g., kitchen, bedroom, living room; Charlop & Trasowech, 1991; Smith, et al., 2016). Also, PTD has proven to produce positive results when used simultaneously with various error correction methods (e.g., controlling prompt, negative feedback, no reinforcement, manual guidance; Carlile et al., 2013; Ingenmey & Houten; 1991; Ledford & Wehby, 2015; Sweeney et al., 2018). The previously mentioned error correction methods result in a near errorless practice for PTD. Finally, PTD was found to be efficacious across target skills (e.g., vocational skills, verbal communication, behavior management, academic and social skills) for participants with ASD (Smith et al., 2016; Matson et al., 1990; Heckaman et al., 1998; Ledford & Wehby, 2015). In sum, our review of published PTD intervention-based articles dating back to 1990 show this time delay procedure to be effective in increasing acquisition of skills in students with ASD. Further, research shows PTD to be an applicable intervention across learning environments. However, despite these positive findings, not all of the studies included generalization measures (n = 8) and follow-up data (n = 7). Therefore, it is difficult to assess the sustainability of learned behaviors and participants'

abilities to transfer and apply acquired skills in settings outside of those used during study conditions. While not all studies included generalization and maintenance measures, intervention data showed PTD to have a functional relationship on skill acquisition in students with ASD.

Limitations

The findings of this review of the literature on PTD should be analyzed within the context of a few limitations. First, all studies used a single-case research design; therefore, participant numbers were low and generalization of research findings are limited. Second, the majority of the studies measured the effects of PTD on participants with ASD only (n = 10). Finally, our search was limited to utilizing two databases to retrieve articles; therefore, other published empirical investigations that measured the effects of PTD on learning acquisition in students with ASD and ID could have been missed. Despite the aforementioned limitations, our review extends the research on PTD and our findings lend implications for research and practical application of PTD.

Implications for Research and Practice

Findings from our 30-year review of the literature lend several implications for research and practice. The first implication for research involves measuring the effects of PTD on secondary students with ASD. The majority of studies (n = 10) were done on elementary aged students; thus, we recommend experimentally measuring the effects of this time delay procedure when teaching older students with the same disability diagnosis. The second implication for research is to increase the amount of teacher-delivered and peer educator-led (i.e., peers who are neurotypical) studies. Increasing the number of teacher and peer educator-led studies may produce faster results as the level of comfortability with the interventionist is also increased. The third implication for research is to collect generalization and follow-up data. A few of the studies

did not measure generalization and maintenance; thus, it is difficult to evaluate sustainability of the intervention and participants' abilities to transfer and apply acquired skills in a novel environment. The fourth implication for research is to ensure there are trained and unbiased observers to code all data. This is a safeguard to ensure reliability in reported findings. Finally, we recommend measuring the efficacy of PTD on more than one task. Doing so would enable researchers to measure the effects of the time delay procedure across behaviors while simultaneously increasing the rigor of the research.

In addition to the aforementioned implications for research, we also offer a few implications for practice based on findings from our review. The first implication for practice involves practical application of PTD when teaching students with ASD. Our review supports the efficacy of using this instructional procedure to teach students with ASD, as PTD consistently resulted in positive learner outcomes across the investigations included in our review. Therefore, we recommend the continued use of PTD when teaching similar learners. The second implication for practice is to increase the application of PTD in a variety of educational settings. The majority of studies (n = 7) took place in the classroom setting. However, PTD interventions were also implemented successfully in other instructional settings (e.g., vocational and practical settings, home settings, and public settings). For that reason, we recommend special education teachers consider PTD as an instructional approach in classroom-based settings as well as other learning environments. As with all instructional decision-making, we recommend ensuring there is a goodness of fit based on individual learning needs and desired skill acquisition prior to implementing PTD or any intervention for that matter. Nonetheless, findings from our 30-year review of the literature support the practical application of PTD when teaching students with ASD.

V. CONCLUSION

PTD is a near-errorless instructional approach that has been shown empirically to result in skill acquisition in students with ASD. In this literature review, we analyzed research published between 1990-2020, all of which evaluated the efficacy of PTD on skill acquisition in elementary or secondary aged students with ASD. Findings support the use of PTD, as reviewed research reported positive outcomes in study participants. That is, across studies, all participants (n = 35) acquired target skills as a result of the PTD intervention. Despite the positive learner outcomes reported, the body of research specific to PTD when teaching students with ASD is relatively limited. While there is enough research to support practical application when teaching students with ASD, we recommend researchers continue to extend the literature base on PTD when teaching this unique population of learners.

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